A Connector And A Connector Assembly

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] The invention relates to a connector and to a connector assembly.

FIELD OF THE INVENTION

[0002] U.S. Patent No. 5,718,596 and FIG. 23(A) herein show a connector used in an automotive electric circuit. With reference to FIG. 23(A), the connector has male and female housings 1, 2 connected with each other. A lock arm 3 is formed on the female housing 2 and engages a locking groove 4 in the male housing 1 to hold the housings 1, 2 together. A slider 5 has a pressing portion 5a that moves into a deformation space 3a for the lock arm 3 to prevent deformation of the lock arm 3.

[0003] The slider 5 is pulled back to retract the pressing portion 5a from the deformation space 3a so that the housings 1, 2 can be separated for maintenance or other reason. The lock arm 3 then is deformed and disengaged automatically from the locking groove 4 and is guided by disengagement guiding surfaces 3b, 4a on the facing surfaces of the lock arm 3 and the locking groove 4. Thus, the connector has a so-called semi-locking construction.

[0004] The connector described above is designed to enable the two housings 1, 2 to be separated easily by pulling the slider 5 to improve a

separating operability. However, this leads to a higher danger of inadvertently separating the connector in circumstances where the separating operation should not be performed (e.g. during power application to an electric circuit). Thus, there has been a demand for a countermeasure.

[0005] The invention was developed in view of the above problem and an object thereof is to prevent housings from being inadvertently separated.

SUMMARY OF THE INVENTION

[0006] The invention relates to a connector with a housing that is connectable with a mating housing. Locking means is provided on the housing for locking the housings together. A slider is assembled with the housing and is movable substantially along a connecting direction of the housings between a prevention area in which cancellation of the locked state by the locking means is prevented and a permission area in which cancellation of the locked state by the locking means is permitted. At least one fixing means is provided between the housing and the slider for fixing the slider in the prevention area.

[0007] The housings are locked together by the locking means. The locked state by the locking means is canceled when the slider is moved from the prevention area. Thus, the fixing means fixes the slider in the prevention area to prevent inadvertent separation of the housings.

[0008] The fixing means preferably is between the housing and the slider and has holes that align when the housings are connected and when the slider is in the prevention area. A fixing member then is insertable through the holes to fix the slider. However, the housings can be separated for maintenance or other reason after the fixed state of the slider by the fixing member is canceled.

[0009] The locking means may include a lock arm on the housing to engage a lock on the mating housing when a properly connected state is reached.

[0010] An unlocking portion preferably is provided on at least one of the slider and the lock arm for disengaging the lock arm from the lock as the slider is moved from the prevention area toward the permission area.

[0011] The housings may be separated for maintenance by canceling the fixed state of the fixing means and moving the slider from the prevention area toward the permission area. The lock arm then is displaced by the unlocking portion, and disengages from the lock. Thus, the housings can be pulled apart.

[0012] The two housings can be unlocked by the unlocking portion and can be separated from each other by moving the slider. Thus, it is unnecessary to adopt the partial locking construction of the prior art connector. Accordingly, the locked state is more stable than the prior art connector if the inventive connector is used with the slider detached.

[0013] The lock arm preferably is displaced resiliently while moving onto the lock in the process of connecting the two housings.

[0014] The slider preferably has a protecting portion for covering a rear end of the locking means when the slider is in the preventing area and at an initial mount position. Accordingly, unintended separation of the housings is improbable. The protecting portion also may cover the unlocking portion.

[0015] The invention also relates to a connector assembly with the above-described connector and a mating connector. The mating connector may be a wire-to-wire connector or a connector mountable to a piece of equipment.

[0016] These and other objects and advantages of the invention will become more apparent upon reading the following description of preferred embodiments and accompanying drawings. It should be understood that even though embodiments are described separately, single features may be combined.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] FIG. 1 is a front view of a male housing according to a first embodiment of the invention.

[0018] FIG. 2 is a partial plan view of the male housing.

[0019] FIG. 3 is an exploded front view of a female housing, compression coil springs and a slider.

[0020] FIG. 4 is an exploded plan view of the female housing, the compression coil springs and the slider.

[0021] FIG. 5 is an exploded rear view of the female housing, the compression coil springs and the slider.

[0022] FIG. 6 is a section along 6-6 of FIG. 3.

[0023] FIG. 7 is a section along 7-7 of FIG. 3.

[0024] FIG. 8 is a section along 8-8 of FIG. 3.

[0025] FIG. 9 is a front view with the slider mounted on the female housing.

[0026] FIG. 10 is a plan view of the slider mounted on the female housing.

[0027] FIG. 11 is a rear view of the slider mounted on the female housing.

[0028] FIGS. 12(A), 12(B) and 12(C) are sections along A-A, B-B and C-C of FIGS. 1 and 9 before the housings are connected.

[0029] FIGS. 13(A), 13(B) and 13(C) are sections similar FIGS. 12(A), 12(B) and 12(C), but showing the slider at an initial mount position while the housings are being connected.

[0030] FIGS. 14(A), 14(B) and 14(C) are sections similar to FIGS. 12(A), 12(B) and 12(C), but showing the slider near a boundary between prevention and permission area while the housings are being connected.

[0031] FIGS. 15(A), 15(B) and 15(C) are sections similar to FIGS. 12(A), 12(B) and 12(C) but showing the slider in the permission area while the housings are being connected.

[0032] FIGS. 16(A), 16(B) and 16(C) are sections similar to FIGS. 12(A), 12(B) and 12(C), but showing the slider at a retreated position when the housings are connected properly.

[0033] FIGS. 17(A), 17(B) and 17(C) are sections similar to FIGS. 12(A), 12(B) and 12(C), but showing the slider moved back to the initial mount position after the housings are connected properly.

[0010] FIGS. 18(A) and 18(B) are sections similar to FIGS. 12(A) and 12(B) but show the slider and coil springs detached in state before the two housings are connected and in a state where the two housings are connected properly.

[0034] FIG. 19 is a rear view showing a state where a slider is mounted on a female housing according to a second embodiment of the invention.

[0035] FIG. 20 is a plan view showing the slider on the female housing.

[0036] FIG. 21 is a side view showing the slider on the female housing.

[0037] FIG. 22 is a section along 22-22 of FIG. 19 showing a state where two housings are connected properly.

[0038] FIGS. 23(A) and 23(B) are sections showing a state immediately before a prior art connector is properly connected and a state where the prior art connector is properly connected.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0039] A connector according to the invention is described with reference to FIGS. 1 to 18. The connector preferably is used in an automotive airbag circuit or similar security sensitive application such as in airplanes. This connector has a male housing 10 and a female housing 20 that are connectable with each other. A slider 50 and two compression coil springs S are incorporated into the female housing 20. In the following description, engaging sides of the two housings 10, 20 are referred to as front and reference is made to FIGS. 3 and 12 concerning vertical direction VD.

[0040] The male housing 10 is made e.g. of a synthetic resin, and has a forwardly projecting rectangular tubular receptacle 11. Terminal fittings 12 are arranged in a widthwise direction WD in cavities 13 in the male housing 10 and connect with ends of unillustrated wires, as shown in FIGS 1, 2 and 12. Each male terminal fitting 12 includes a tab 12a that projects forwardly from the back surface of the receptacle 11. Flat plate-shaped short-terminating ribs 14 project from the back surface of the receptacle 11 above the respective tabs 12a and extend to substantially the same position as the front ends of the tabs 12a.

[0041] A lock 15 projects at a substantially widthwise middle of the upper surface of the receptacle 11 slightly spaced from the front end of the receptacle 11. A front surface 15a of the lock 15 is sloped up to the back, whereas a rear surface 15b is substantially vertical. The rear surface 15b of the lock 15 may be

an overhanging or undercut surface. Two pushing portions 16 project at opposite sides of the lock 15 at the front end of the upper surface of the receptacle 11. A front surface 16a of each pushing portion 16 is substantially vertical and normal to a connecting direction CD of the housings 10, 20, whereas a rear surface 16b thereof is sloped down to the back. Three long narrow connection guiding ribs 17 extend substantially along the connecting direction CD on the opposite lateral surfaces and the bottom surface of the receptacle 11.

[0042] The female housing 20 is made e.g. of a synthetic resin and has a terminal accommodating portion 21 for accommodating female terminal fittings 24. A substantially rectangular outer tube 22 surrounds a front part of the terminal accommodating portion 21, as shown in FIGS. 3 to 8. A substantially annular forwardly open connecting groove 23 is formed between the terminal accommodating portion 21 and the outer tube 22 and is configured to receive the receptacle 11 of the male housing 10. Cavities 25 are arranged substantially in a widthwise direction WD in the terminal accommodating portion 21 and are dimensioned to receive the female terminal fittings 24 that have been connected with ends of wires D by crimping, insulation displacement, welding, soldering or the like. The terminal fittings 24 are insertable from behind in an insertion direction ID. The female terminal fitting 24 is accommodated in a small-diameter front half of each cavity 25, whereas a sealing member 26 fixed to a connection portion of each female terminal fitting 24 together with the wire D is fit in a large-diameter rear half of each cavity 25 to seal the cavity 25.

[0043] A forwardly-open locking groove 27 is formed in the bottom wall of each cavity 25 and receives a metallic lock 24a of the female terminal fitting 24. The lock 24a is formed by cutting and bending a portion of a main body of the female terminal fitting 24 and engages the rear surface of the locking groove 27 to lock the female terminal fitting 24 in the cavity 25. A retainer 29 is mountable into the terminal accommodating portion 21 through a retainer mount hole 28 in the outer tube 22. The retainer 29 includes locking sections 29a corresponding to openings 30 in the side walls of the respective cavities 25 slightly behind the locking grooves 27. The retainer 29 is movable substantially along a widthwise direction WD between a partial locking position and a full locking position. The locking sections 29a are in the respective openings 30 and retracted from the corresponding cavities 25 when the retainer 29 is in the partial locking position. Thus, the female terminal fittings 24 can be inserted into and withdrawn from the cavities 25. However, the respective locking sections 29a enter the corresponding cavities 25 to engage jaws 24b of the main bodies of the female terminal fittings 24 when the retainer 29 is in the full locking position. A seal ring 31 is mounted behind the retainer 29 on the outer peripheral surface of the terminal accommodating portion 21. The seal ring 31 is squeezed between the receptacle 11 and the terminal accommodating portion 21 to provide sealing between the housings 10, 20

[0044] A forwardly-open shorting-terminal accommodating chamber 33 is formed in the front of the terminal accommodating portion 21 above the cavities 25 and accommodates a conductive shorting terminal 32 for shorting the respective female terminal fittings 24. The shorting terminal 32 has a wide

plate-shaped main body that can be can be pressed into the upper end of the shorting-terminal accommodating chamber 33. Communication holes 34 provide communication between the shorting-terminal accommodating chamber 33 and the vertically adjacent cavities 25. Resilient contact pieces 32a project back from the main body of the shorting terminal 32 for resilient contact with the female terminal fittings 24 in the respective cavities 25. The resilient contact pieces 32a have forwardly-cantilevered free ends that are resiliently deformable up and down in a direction intersecting the connecting direction CD.

[0045] Slits are formed in the upper part of the outer tube 22 to form a lock arm 35 substantially in the widthwise middle of the outer tube 22. The lock arm 35 is cantilevered forwardly, and the free front end is resiliently deformable up and down in a direction intersecting the connecting direction CD. A groove 36 is formed in the lower surface of the lock arm 35 and is dimensioned to receive the lock 15 of the male housing 10. The groove 36 has an open rear end, as shown in FIG. 7, and a closed front end defined by a front surface 36a. The front surface 36a of the groove 36 is aligned to conform to the inclination of the rear surface 15b of the lock 15, and is engageable with the lock 15. An unlock pushable portion 37 projects out from the upper surface of the rear end of the lock arm 35 and has substantially the same width as the lock arm 35. Opposite sides of the unlock pushable portion 37 substantially correspond to the supported portion of the lock arm 35 and project forward a short distance on the lock arm 35. Front surfaces 37a of these opposite sides slant up to the back.

[0046] Two push canceling portions 38 are provided on the upper part of the outer tube 22 at opposite sides of the lock arm 35. The push canceling portions

38 are about half the height of the lock arm 35, and front surfaces 38a of the push canceling portions 38 slant up and to the back. Two spring receiving portions 39 are on the upper part of the outer tube 22 at outer sides of the push canceling portions 38, and the compression coil springs S can be accommodated from the front in the spring receiving portions 39. Each spring receiving portion 39 is a bottomed hole with an open front end and an upper wall that is cut off up to a specified depth. The inner surface of each spring receiving portion 39 has an arcuate shape that substantially fits the compression coil spring S and the rear wall of each spring receiving portion 39 can receive the rear end of the corresponding compression coil spring S.

[0047] Two front-stops 40 project from the upper part of the outer tube 22 at the outer sides of the spring receiving portions 39. The front surfaces of the front-stops 40 slope up and to the back, whereas the rear surfaces thereof are substantially vertical and normal to the connecting direction CD. Two guiding grooves 41 are formed on the lower side of the outer tube 22 substantially opposite from the front-stops 40. Two female-housing operating portions 42 are provided at opposite sides of the rear end of the outer tube 22. The female-housing operating portions 42 are stepped so that the width of the female housing 20 is reduced stepwise toward the rear end. Thus, the female housing 20 easily can be pushed forward from behind. Connection guiding grooves 43 are provided in the inner surface of the outer tube 22 for receiving the respective connection guiding ribs 17 of the male housing 10.

[0048] A wide plate-shaped slider 50 made e.g. of a synthetic resin is mountable on the upper surface of the outer tube 22. The slider 50 is mounted

on the female housing 20 for relative movement substantially along a connecting direction CD between an initial mount position (see FIGS. 12) and retreated position (FIG. 16). The slider 50 in the initial mount position (FIG. 12) is at its foremost position with respect to the female housing 20 so that the front end of the slider 50 aligns with the front end of the female housing 20. The slider 50 in the retreated position (see FIGS. 16) is at its rearmost position with respect to the female housing 20 so that the rear end of the slider 50 substantially aligns with the rear end of the outer tube 22. The slider 50 has a length that preferably is about half the length of the female housing 20, and a width larger than the width of the female housing 20. The slider 50 may move along a direction slightly inclined with respect to the connecting direction CD of the housings 20, 10 (e.g. at an angle less than about 10°). However, the movement component of the slider 50 along the connecting direction CD is sufficient to build up a biasing force in the biasing member S that will separate the housings 20, 10 if the connection process is interrupted before reaching a proper connection of the housings 20, 10. The inclined movement of the slider 50 along the connecting direction CD is encompassed by the description of the slider 50 moving substantially along the connecting direction CD.

[0049] An unlock pushing portion 51 projects down at a substantially widthwise middle of the bottom surface of the slider 50. A rear surface 51a of the unlock pushing portion 51 slopes up and back, and has substantially the same inclination as the front surface 37a of the unlock pushable portion 37. A front surface 51b of the unlock pushing portion 51 slopes up and to the front, and has an inclination more moderate than the rear surface 51a. The unlock

pushing portion 51 projects by a distance to reach close to the upper surface of the lock arm 35 with the slider 50 mounted on the female housing 20. Additionally, the unlock pushing portion 51 overlaps the unlock pushable portion 37 along a vertical direction VD and faces the unlock pushable portion 37 along the connecting direction CD (see FIG. 12(B)). The unlock pushing portion 51 enters a deformation space 44 for the lock arm 35 to prevent the resilient displacement of the lock arm 35 while the slider 50 is moved back to a position shown in FIGS. 14 from the initial mount position of FIGS. 12. A moving area of the slider 50 defines a prevention area where unlocking is prevented. On the other hand, the unlock pushing portion 51 is retracted from the deformation space 44 for the lock arm 35 when the slider 50 is moved back from the prevention area. Thus, resilient deformation of the lock arm 35 is permitted (see FIG. 15(B)). In other words, a moving area of the slider 50 from the rear end (see FIGS. 14) of the prevention area to the retreated position (see FIGS. 16) defines a permission area where unlocking is permitted. The unlock pushing portion 51 can push the unlock pushable portion 37 when the slider 50 reaches the retreated position. Thus, the lock arm 35 can undergo an upward displacement (see FIG. 16(B)). The moving area of the slider 50 consists of the prevention area at the front side and the permission area at the backside.

[0050] Two pushable arms 52 project from the bottom surface of the slider 50 at the opposite sides of the unlock pushing portion 51. Each pushable arm 52 is cantilevered rearwardly from the front end of the slider 50. A hook 53 projects down at the extending end of the pushable arm 52. A rear surface 53a of the hook 53 slopes up and to the back, whereas a front surface 53b is

substantially vertical. The pushable arms 52 can be displaced resiliently up and down toward and away from a main body of the slider 50 with the front ends thereof as supporting points. Deformation spaces 54 are defined between the pushable arms 52 and the main body of the slider 50. The pushable arms 52 are covered by the main body of the slider 50, and thus are protected without being exposed to the outside. The pushable arms 52 are at opposite sides of the lock arm 35 in the mounted state of the slider 50. The deformation spaces 54 for the pushable arms 52 and the deformation space 44 for the lock arm 35 overlap along the vertical direction VD (see FIG. 9). Additionally, the hooks 53 overlap the push canceling portions 38 and the pushing portions 16 of the male housing 10 along the height direction (see FIG. 12(A)). Accordingly, the pushing portions 16 can push the hooks 53 back along the connecting direction CD in the process of connecting the housings 10, 20. Accordingly, the slider 50 is moved back with respect to the female housing 20 (see FIGS. 13 and 14). The hooks 53 move onto the push canceling portions 38 as the housings 10, 20 are connected and the pushable arms 52 are displaced up to cancel the pushed state of the hooks 53 by the pushing portions 16 (see FIGS. 16).

[0051] Two spring pressing portions 55 are provided at the outer sides of both pushable arms 52 of the slider 50 for holding the compression coil springs S at their front-limit positions. Each spring pressing portion 55 has a substantially L-shape cross section with a front wall that presses the front end of the corresponding compression coil spring S and a wall that extends forward and back along the connecting direction CD. The compression coil springs S are compressed resiliently between the spring pressing portions 55 and the

spring receiving portions 39 to accumulate biasing forces to separate the housings 10, 20 as the slider 50 is moved from the initial mount position toward the retreated position (see FIG. 15(C)). Further, arcuate inner peripheral surfaces of the walls of the spring receiving portions 39 extend forward and back and are conform to the shape of the compression coil springs S.

[0052] Front-stop grooves 56 are formed in the bottom surface of the slider 50 outwardly of the spring pressing portions 55 and receive the front-stops 40 of the female housing 20. The front-stop grooves 56 open forward and down and have a depth to reach a position close to the rear end of the slider 50. The rear surfaces of the front-stop grooves 56 are substantially vertical and contact the rear surfaces of the front-stops 40 of the female housing 20 (see FIG. 10) to prevent the slider 50 from moving forward from the initial mount position.

[0053] Two guides 57 project down toward the female housing 20 from the opposite sides of the slider 50 and then project inward. Accordingly, the guides 57 have C-shapes when seen in section (see FIG. 3). The guides 57 fit in the guiding grooves 41 of the female housing 20 in the mounted state of the slider 50 to guide relative movements of the slider 50 with respect to the female housing 20 (see FIG. 9). Two slider operating portions 58 are provided at the opposite side surfaces of the rear end of the slider 50. The slider operating portions 58 are stepped to bulge out sideways to a larger degree toward the back. Thus, the slider 50 can be pulled back from the front (see FIG. 10).

[0054] The connector also has a fixing means for fixing the slider 50 immovably with respect to the female housing 20. The fixing means has a fixing portion 45 that projects laterally from the left surface of a front end of the outer

tube 22 of the female housing 20 shown in FIG. 3. The fixing portion 45 has a flat plate-shaped main portion 45a that is cantilevered substantially horizontally and that is supported by two reinforcing ribs 45b at the opposite front and rear ends of the lower surface of the main portion 45a. The main portion 45a has a substantially round hole 45c that penetrates the main portion 45a vertically and preferably substantially normal to the connecting direction CD. A fixing portion 59 projects laterally more than the slider operating portion 58 from the left surface of a front end of the slider 50 shown in FIG. 3. The fixing portion 59 is a structure obtained by vertically inverting the fixing portion 45 of the female housing 20, and a main portion 59a supported by reinforcing ribs 59b is formed with a substantially round hole 59c that vertically penetrates the main portion 59a. The holes 45c, 59c of both fixing portions 45, 59 align with each other (see FIGS. 9 and 10) when the slider 50 is at the initial mount position on the female housing 20. A pin or a wire W is vertically insertable through the substantially aligned holes 45c, 59c as indicated by phantom in FIG. 9. Thus, the slider 50 can be fixed by the wire W and is immovable from the initial mount position with respect to the female housing 20.

[0055] The female connector 20 is assembled by inserting the compression coil springs S into the corresponding spring receiving portions 39 of the female housing 20 from the front, as shown in FIGS. 6 to 8. The slider 50 then is mounted on the upper side of the outer tube 22 from the front to attain the state shown in FIGS. 9 to 12. In the process of mounting the slider 50, the rear walls of the front-stop grooves 56 temporarily move onto the front-stops 40, and then move over the front-stops 40 when the slider 50 reaches the initial mount

position. Thus, the rear surfaces of the front-stops 40 contact the back surfaces of the front-stop grooves 56 so that the slider 50 will not move forward from the initial mount position (see FIG. 10). The compression coil springs S are compressed slightly at the initial mount position (see FIG. 12(C)), and hence suppress shaking of the slider 50 along the connecting direction CD. Additionally, the unlock pushing portion 51 enters the deformation space 44 above the lock arm 35 to prevent displacement of the lock arm 35 (see FIG. 12(B)). Assembly proceeds by mounting the seal ring 31 on the terminal accommodating portion 21. The retainer 29 then is mounted at the partial locking position and the shorting terminal 32 is accommodated into the shorting-terminal accommodating chamber 33. The female terminal fittings 24 are crimped or otherwise connected with the wires D and are inserted into the cavities 25. The retainer 29 then is moved to the full locking position to lock the female terminal fittings 24 in cooperation with the metallic locks 24a. Of course, the respective parts may be assembled in an order and by a method other than the order and method described above.

[0056] The slider 50 is substantially plate-shaped and is mounted on one side surface of the female housing 20. Thus, the connector is small and the slider 50 is mounted easily on the female housing 20, as compared to a case where the slider 50 is a frame-shaped, as in the prior art connector.

[0057] The two housings 10, 20 are connected by aligning the receptacle 11 with the connecting groove 23 along the connecting direction CD and pushing the female-housing operating portions 42 forward. The front surfaces 16a of the pushing portions 16 contact with the front surfaces 53b of the hooks 53 of the

pushable arms 52 (see FIG. 13(A)) when the receptacle 11 enters the connecting groove 23 to a specified depth. As a result, the pushing portions 16 push the pushable arms 52 back and move the slider 50 back from the initial mount position, as shown in FIGS. 14. The spring pressing portions 55 support the front ends of the compression coil springs S, while the spring receiving portions 39 support the rear ends of the compression coil springs S. Thus, the relative backward movement of the spring pressing portions 55 compress the compression coil springs S so that the springs S accumulate biasing forces for separating the two housings 10, 20 (see FIG. 14(C)).

[0058] The connecting operation could be interrupted while the two housings 10, 20 are connected only partly. In this situation, the biasing forces accumulated thus far in the resiliently compressed coil springs S are released. As a result, the hooks 53 of the pushable arms 52 of the slider 50 push the pushing portions 16 back to separate the housings 10, 20. Thus, the two housings 10, 20 are prevented from being left partly connected.

[0059] The unlock pushing portion 51 retracts from the deformation space 44 for the lock arm 35 as the slider 50 is moved back from the prevention area (FIGS. 14) to the permission area. Thus, the lock arm 35 moves onto the front surface 15a of the lock 15 and resiliently displaces in a direction intersecting the connecting direction CD (see FIG. 15(B)). At this time, the rear surfaces 53a of the hooks 53 contact the front surfaces 38a of the push canceling portions 38 (see FIG. 15(A)). In this process, the tabs 12a of the male terminal fittings 12 contact the female terminal fittings 24, the short-terminating ribs 14 contact the resilient contact pieces 32a, and the front end of the receptacle 11 contacts the

seal ring 31. The hooks 53 move onto the push canceling portions 38 as the connection progresses and the pushable arms 52 are displaced up. Areas of engagement of the front surfaces 16a of the pushing portions 16 with the front surfaces 53b of the hooks 53 gradually decrease as the pushable arms displace up.

[0060] The slider 50 is pushed to the retreated position as the housings 10, 20 become properly connected and the pushing portions 16 no longer push the hooks 53 (see FIG. 16(A)). At this time, the lock arm 35 has moved over the lock 15 (see FIG. 16(B)). However, the unlock pushing portion 51 pushes the unlock pushable portion 37 and holds the lock arm 35 in a resiliently displaced condition. The compression coil springs S are released when the pushed state by the pushing portions 16 is cancelled and the slider 50 starts moving forward. As a result, the unlock pushing portion 51 no longer pushes the unlock pushable portion 37 and the lock arm 35 is restored resiliently. The lock 15 enters the groove 36 as the lock arm 35 is restored and the front surface 36a of the groove 36 engages the rear surface 15b of the lock 15 to hold the housings 10, 20 together. The hooks 53 move over the pushing portions 16 when the slider 50 moves forward to the initial mount position. Thus, the pushable arms 52 are restored resiliently (see FIG. 17(A)) and the rear surfaces 53a of the hooks 53 contact the rear surfaces 16b of the pushing portions 16. Additionally, the unlock pushing portion 51 enters the deformation space 44 and prevents displacement of the lock arm 35 (see FIG. 17(B)). Accordingly, the connector has a double-locking construction.

[0061] The male and female terminal fittings 12, 24 are connected properly when the housings 10, 20 reach the properly connected state. Additionally, the short-terminating ribs 14 deform the resilient contact pieces 32a of the shorting terminal 32 away from the corresponding female terminal fittings 24. As a result, the shorted state of the female terminal fittings 24 is canceled. Further, the seal ring 31 is squeezed between the receptacle 11 and the terminal accommodating portion 21 to provide sealing between the housings 10, 20.

[0062] In the properly connected state, the slider 50 is at the initial mount position and the holes 45c, 59c of the fixing portion 59 of the slider 50 and the fixing portion 45 of the female housing 20 align. Thus, as indicated by phantom in FIG. 9, the wire W is introduced through the holes 45c, 59c from above or below. In this state, the wire W catches the edges of the holes 45c, 59c. The slider 50 could be pulled back when the connector should not be separated, for example, because power is applied to an airbag circuit. However, the wire W prevents the slider 50 from moving back with respect to the female housing 20 from the prevention area to the permission area. The slider 50 may move slightly due to play between the wire W and the holes 45c, 59c, but such movement is not sufficient for the slider 50 to reach the permission area.

[0063] The two housings 10, 20 may have to be separated for maintenance or other reason. In such a case, the slider operating portions 58 of the slider 50 are held and pulled to move the slider 50 back with respect to the housings 10, 20. Thus, the unlock pushing portion 51 is retracted back from the deformation space 44 for the lock arm 35, and the rear surfaces 53a of the hooks 53 slide along the rear surfaces 16b of the pushing portion 16 to move the hooks 53

onto the pushing portion 16. Thus, the pushable arms 52 are displaced resiliently up. In this process, the compression coil springs S are compressed. The unlock pushable portion 37 is pushed by the unlock pushing portion 51 when the slider 50 is pulled to the retreated position as shown in FIGS. 16. This pushing force displaces the lock arm 35 due to the inclination of the front surface 37a of the unlock pushable portion 37 (see FIG. 16(B)). The locked state of the housings 10, 20 is canceled when the lock arm 35 is displaced sufficiently for the front surface 36a of the groove 36 to disengage completely from the rear surface 15b of the lock 15. Thus, the female housing 20 can be pulled apart from the male housing 10. The lock arm 35 then moves over the lock 15 and resiliently restores. Thus, the compression coil springs S are released and the female housing 20 is moved back with respect to the slider 50 to the initial mount position. In this way, the operation of moving the slider 50 back, the operation of resiliently displacing the lock arm 35 to cancel the locked state and the operation of pulling the housings 10, 20 apart is performed merely by pulling the slider 50 back.

[0064] The prior art connector of FIGS. 19 has a semi-locking construction to facilitate separation, and the slider 4 prevents displacement of the lock arm 3 to compensate for an insufficient holding force of the semi-locking construction between the prior art housings 1, 2. Thus, a holding force of the housings 1, 2 is insufficient if the prior art housings 1, 2 are connected without the slider 4.

[0065] In contrast, the unlock pushing portion 51 of the slider 50 of the subject invention engages the unlock pushable portion 37 on the female housing 20 to displace the lock arm 35 for facilitating separation. Thus, the

connector of the subject invention does not need a semi-locking construction. Accordingly, the locked state of the housings 10, 20 is not canceled automatically if a pulling force on the connected housings 10, 20. More specifically, the rear surface 15b of the lock 15 is substantially vertical and the front surface 36a of the groove 36 in the lock arm 35 is undercut. Thus, the housings 10, 20 can be locked with a sufficient holding force even if the slider 50 does not prevent resilient displacement of the lock arm 35. Accordingly, the connector of this embodiment can be used without the slider 50 and the compression coil springs S if a partial connection preventing function is not needed, and costs can be remarkably reduced.

[0066] As described above, the holes 45c, 59c of the fixing portions 45, 59 align when the housings 10, 20 are connected properly and when the slider 50 is at the initial mount position. Thus, the slider 50 can be fixed so as not to be movable from the prevention area toward the permission area by inserting the wire W through the holes 45c, 59c. This prevents the two housings 10, 20 from being inadvertently separated.

[0067] A second embodiment of the invention is described with reference to FIGS. 19 to 22. The positions of fixing portions are changed in the second embodiment. However, no repetitive description is given for elements that have the similar or same construction as in the first embodiment. Rather those same or similar elements merely are identified by the same reference numerals.

[0068] A protecting portion 60 capable of covering a rear end of the lock arm 35 at an initial mount position is provided substantially in the widthwise center of the rear end of the slider 50. The protecting portion 60 is substantially

inverted U-shaped when viewed from behind and has a widthwise main portion 60a and two sides 60b that project toward the housing 20 from opposite lateral edges of the main portion 60a. The rear ends of the protecting portion 60 and the outer tube 22 substantially align when the slider 50 is at the initial mount position, the unlock pushable portion 37 is covered by the main portion 60a from above, and the sides 60b are between the lock arm 35 and spring receiving portions 39. A fixing portion 59A projects back substantially along the connecting direction CD from the left side 60b of the protecting portion 60 in FIG. 19. The fixing portion 59A includes a main portion 59Aa in the form of a vertically extending plate and a substantially round hole 59Ac penetrates the main portion 59Aa in a widthwise direction WD. A fixing portion 45A projects back from a position on the rear end surface of the outer tube 22 of the female housing 20 substantially corresponding to the left spring receiving portion 39 in FIG. 19. The fixing portion 45A includes a vertically extending main portion 45Aa that is supported by two reinforcing ribs 45Ab at opposite upper and lower ends of the left side surface thereof. The main portion 45Aa of the fixing portion 45A has a hole 45Ac similar to the hole 59Ac. The holes 45Ac, 59Ac of the fixing portions 45A, 59A substantially align when the slider 50 held at the initial mount position (see FIG. 20). As described above, both fixing portions 45A, 59A have a positional relationship to overlap the outer tube 22 with respect to the vertical direction VD and/or the widthwise direction WD and overlap the terminal accommodating portion 21 with respect to the longitudinal direction so as not enlarge the outer shape of the female connector 20.

[0069] The rear end of the lock arm 35, including the unlock pushable portion 37, is covered by the protecting portion 60 when housings 10, 20 are connected properly, as shown in FIG. 22. Additionally, resilient displacement of the lock arm 35 is prevented by the unlock pushing portion 51 of the slider 50 at the initial mount position. Thus, unlocking is prevented redundantly. A wire or pin W then is inserted sideways in a direction intersecting the connecting direction CD through the aligned holes 45Ac, 59Ac, as indicated by phantom in FIG. 20. Thus, the slider 50 can be fixed so as to be immovable backward from the initial mount position with respect to the female housing 20.

[0070] The invention is not limited to the above described and illustrated embodiments. For example, the following embodiments are also embraced by the technical scope of the present invention as defined by the claims. Beside the following embodiments, various changes can be made without departing from the scope and spirit of the present invention as defined by the claims.

[0071] Although the slider is fixed to the female housing in the respective foregoing embodiments, the slider may be fixed to the male housing or to both male and female housings according to the present invention.

[0072] A wire is shown as the fixing member in the foregoing embodiments. However, a resin pin or a metal bolt may be used as a fixing member and may be inserted through both holes. Alternatively, both fixing portions may be welded ultrasonically or may be adhered to each other by an adhesive.

[0073] The unlock pushing portion prevents resilient displacement of the lock arm in the foregoing embodiments. However, the slider may have a

resilient displacement preventing portion separate from the unlock pushing portion for preventing the resilient displacement of the lock arm.

[0074] The slider may have no function of preventing displacement of the lock arm. Thus, an operation of disengaging the lock arm from the lock from outside is prevented when the slider is in the prevention area and such an operation is permitted when the slider is in the permission area.

[0075] Although the connector having the partial connection preventing function is described in the foregoing embodiments, the invention is also applicable to connectors having no partial connection preventing function.

[0076] An embodiment in which the slider and the compression coil springs are assembled into the male housing and the slider is pushed by the female housing is also embraced by the present invention.

[0077] Although the wire-to-wire connector is illustrated in the foregoing embodiments, the present invention is also applicable to a connector of such a type in which the male housing is directly connected with an equipment.

[0078] Although the compression coil springs are illustrated as the biasing member in the foregoing embodiments, leaf springs or the like may be used.

[0079] Although the connector has a watertight function in the foregoing embodiments, the invention is also applicable to non-watertight connectors.